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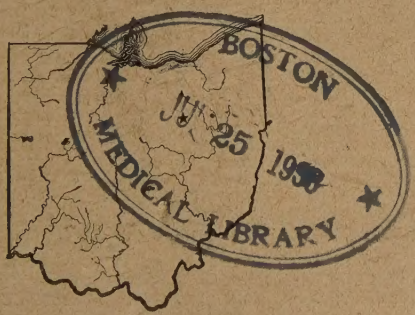
MONTHLY BULLETIN

OF THE

OHIO Agricultural Experiment Station

A report on the progress of the investigations of the Ohio Agricultural Experiment Station, sent free to all residents of the State who request it.



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Wooster, Ohio, U. S. A.

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of the

Ohio Agricultural Experiment Station

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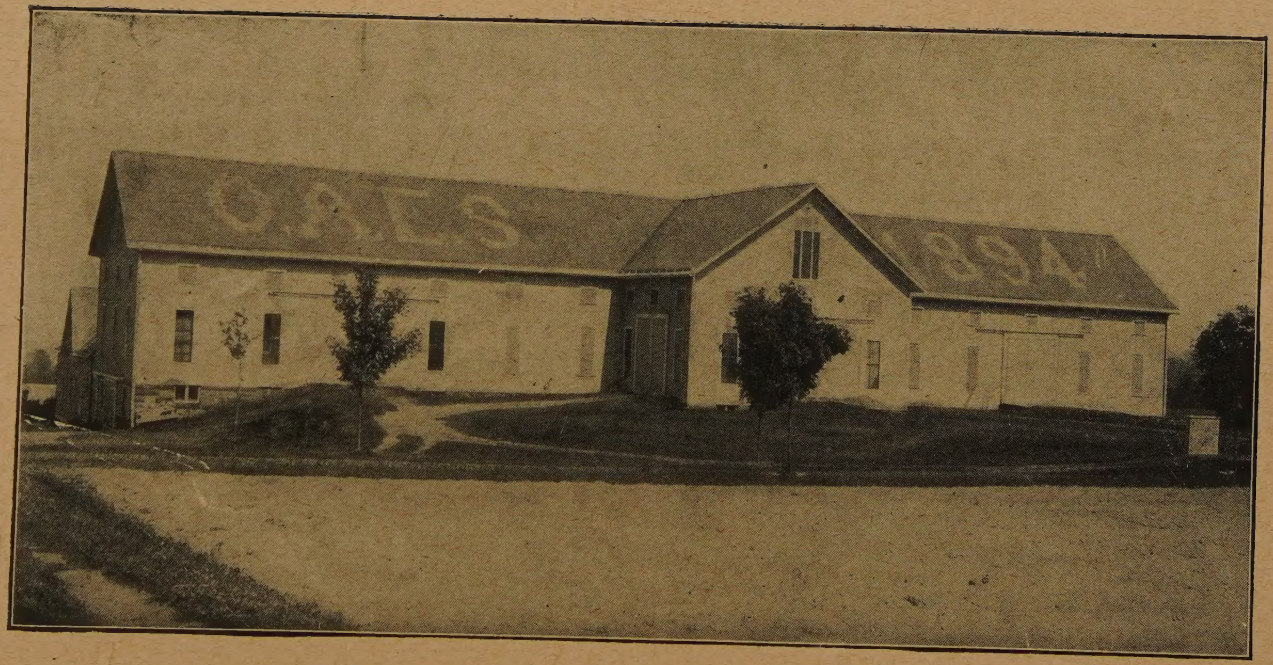

Dairy barn at the Ohio Agricultural Experiment Station

MONTHLY BULLETIN

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VOL. I JUNE, 1916 NO. 6

VARIETY VS. SIMPLE RATIONS FOR LAYING HENS[1]

W. J. BUSS

A series of experiments was begun at the Ohio Experiment Station in 1912 to determine whether rations containing a large variety of feeds give enough better returns to justify the extra trouble and expense involved in supplying them. Two experiments of this series have been completed and some of the results are presented herewith.

Prices used in calculations.—The following prices per hundredweight for feeds were used in financial calculations:

Shelled corn	$1.00	Meat scrap	$2.75
Ground corn	1.09	Linseed oilmeal	1.80
Wheat	1.50	Oyster shells	.75
Oats	1.25	Grit	.75
Bran	1.40	Charcoal	2.25
Middlings	1.40		

No charge has been made for the range occupied by the various lots.

All feeds used in these experiments were of good quality. The meat scrap was guaranteed by the manufacturers to contain 50 percent crude protein. Five samples analyzed by the Department of Chemistry of this Station at various times during the last 2 years have averaged 55.04 percent crude protein. The linseed oilmeal was old process, finely ground.

Prices of eggs per dozen as used in calculations, for 4-week periods beginning approximately on dates given, were as follows:

	Cents		Cents
January 1	31	July 16	21
January 29	28½	August 13	23½
February 26	23	September 10	25
March 26	19	October 8	27
April 23	19	November 5	32½
May 21	19½	December 3	34
June 18	20		

[1]Extract from Ohio Agr. Exp. Sta. Bul. 291.

The reader should bear in mind that it is impossible to use a scale of prices for commodities that will apply through a period of years. In fact, prices that prevail for feeds in different sections of the State at the same time are likely to vary considerably. The prices for feeds as given above are believed not to vary greatly from the average Ohio farm price for them through a period of years. The prices of eggs are possibly a little higher than are realized by most poultrymen, although many who devote some attention to intelligent marketing dispose of their eggs at higher prices than those given above. These arbitrary prices serve only as a means of comparing various lots on a basis of prices given. The reader, in trying to determine which rations will yield best results under his local conditions, should apply local prices to the amounts of feed consumed and number of eggs produced rather than assume that the financial statements will apply in all sections of the State.

EXPERIMENT I

NOVEMBER 24, 1912 TO OCTOBER 6, 1915 (1,047 DAYS)

Description of fowls.—S. C. White Leghorns hatched at the Experiment Station in the spring of 1912 were used in this experiment. There were 24 pullets in each lot.

Quarters.—Prior to August 15, 1913, each lot was housed in a colony house 10 by 12 feet in size, and had access to two yards each 38 by 200 feet in size. After this date each lot occupied only half of a house of the size mentioned above, and had access to one of the yards. About half of each of these yards was closely planted to trees, which furnished an abundance of shade. The yards supplied grass throughout the spring and summer. The fowls had access to the yards at all times except when the ground was covered with snow.

Rations.—The following grain and mash mixtures were used in this experiment (proportions are by weight):

Lot 1. Grain—Shelled corn.
Mash—Ground corn, 16¼; meat scrap, 10.
After Jan. 28, 1914; ground corn, 8; meat scrap, 5.
Lot 2. Grain—Shelled corn.
Mash—Ground corn, 11; bran, 4; meat scrap, 8.
Lot 3. Grain—Shelled corn, 2; wheat, 3; oats, 1.
Mash—Ground corn, 10; bran, 10; meat scrap, 7.

The hens had access to hoppers containing grit, oyster shells and charcoal.

The grain rations were fed twice daily (in the early morning and in the late afternoon) in two equal parts. The mash mixtures

fed dry were kept in self-feeding hoppers to which the hens had access at all times. The amount of grain was so adjusted that the hens would consume about half as much mash as grain.

Summary of results.—A summary of the results of this experiment is shown in Table I.

TABLE I.—Summary of results

Lot	Average number in lot	Mortality	Gain in weight per hen	Grain and mash consumed per hen	Cost of feed per hen	Eggs produced per hen	Cost of feed per dozen eggs produced	Value of eggs per hen	Difference between cost of feed and value of eggs
			Pound	Pounds	Dollars		Cents	Dollars	Dollars
1	20.86	7	0.48	174.55	2.27	351.2	7.74	6.45	4.18
2	19.20	9	.53	168.88	2.19	292.6	8.99	5.28	3.09
3	22.14	8	.34	190.72	2.77	370.5	8.98	6.88	4.11

One would naturally expect a higher rate of mortality in Lot 1 receiving a ration of corn and meat scrap than in the other lots, but such did not prove to be the case in this experiment, as fewer hens died in this lot than in either of the others. Too much emphasis should not be placed on the effect of the rations upon the rate of mortality, as other factors have considerable influence on the mortality. For example, when the pullets are divided into lots, there may be some that, though apparently as strong as others, will later develop constitutional weakness that may result in early death. The mortality in none of the lots was heavier than may be expected with vigorous stock fed to produce a heavy egg yield.

The hens in Lots 1 and 2 gained more in weight than did those in Lot 3. Had the hens in Lot 3 produced no more eggs than did those in the other lots they probably would have gained as much in weight. The birds in all three lots kept in sufficiently good condition for laying hens.

The average grain and mash consumption per hen was 9.3 percent higher for Lot 3, and 3.2 percent lower for Lot 2 than for Lot 1. The cost of feed per hen, on the basis of prices given above, was 3.3 percent lower for Lot 2 and 22.4 percent higher for Lot 3 than for Lot 1. The cost of feed per dozen eggs produced was 16.1 percent higher for Lots 2 and 3 than for Lot 1.

The average egg production per hen was 5.2 percent lower for Lot 1, receiving a ration of corn and meat scrap, than for Lot 3, receiving a ration of corn, wheat, oats, bran and meat scrap, and 20 percent higher than for Lot 2, receiving a ration of corn, bran and meat scrap. The production of Lot 2 was rather low as compared with the other lots. This low production was in all probability due

to causes other than the ration used for this lot. In the second experiment in this series (discussed in the following pages) the lot receiving a ration of corn, bran and meat scrap produced a few more eggs than did the lot receiving a ration of corn and meat scrap.

The figures given in the last column of the preceding table show that the difference between cost of feed and value of eggs per hen was slightly in favor of Lot 1. With corn charged at a higher price and wheat at a lower price, this difference would be in favor of Lot 3. The reader should bear in mind that it is always important to consider prices for feeds as well as their relative efficiency in making up the poultry ration. It is probably safe to say that as a general rule, the difference between the prices of corn and of wheat will be great enough to make the ration of corn and meat scrap more economical than the variety ration used in this experiment, which itself is a relatively simple ration when compared with many that have been recommended and, in fact, are being recommended at present.

EXPERIMENT II

DECEMBER 4, 1913 TO OCTOBER 6, 1915 (672 DAYS)

Description of fowls.—In the second experiment in the study of variety and simple rations for laying hens, S. C. White Leghorn pullets hatched in the spring of 1913 were used. There were 25 pullets in each lot. They were apparently thrifty pullets, and the reason for the rather low egg production secured from these lots is not known. It may have been due in part to the small amount of house room available for them. However, the lots were uniform, and it is believed that results secured from the various lots are comparable.

Quarters.—Each lot of hens was housed in half of a colony house 10 by 12 feet in size. When there was snow on the ground the hens were confined to the houses. The hens were also confined to the houses from April 1 to June 27, 1915, in order to permit the grass in the lots to get some growth. At other times each lot had access to a yard similar to the ones described on page 164.

Rations.—The following rations were used in this experiment:

Lot 1. Grain—Shelled corn.
Mash—Ground corn, 8; meat scrap, 5.
Lot 2. Grain—Shelled corn.
Mash—Ground corn, 7; bran, 3; meat scrap, 5.
Lot 3. Grain—Shelled corn, 1; wheat, 4; oats, 1.
Mash—Ground corn, 3; bran, 4; middlings, 4; oilmeal, 1; meat scrap, 2.

Each lot had access to grit, oyster shells and charcoal. The method of feeding was the same as that used in the experiment discussed in the preceding pages (see p. 164).

Summary of results.—The results of this experiment are presented briefly in the following table:

TABLE II.—Summary of results

Lot	Average number in lot	Mortality	Gain in weight per hen	Grain and mash consumed per hen	Cost of feed per hen	Eggs produced per hen	Cost of feed per dozen eggs produced	Value of eggs per hen	Difference between cost of feed and value of eggs
			Pound	Pounds	Dollars		Cents	Dollars	Dollars
1	21.60	5	0.36	106.07	1.35	185.9	8.73	3.44	2.09
2	20.77	8	.36	105.76	1.35	189.8	8.54	3.50	2.15
3	23.93	2	.11	124.34	1.84	201.6	10.96	3.82	1.98

The mortality in Lot 1 was no higher than normally may be expected; that in Lot 2 was rather high, and that in Lot 3, unusually low. As stated in a preceding paragraph, factors other than the rations used probably have considerable influence upon the mortality.

In this experiment, as in the first, the hens in Lots 1 and 2 gained more in weight than did those in Lot 3. The weight of laying hens, so long as it is not dependent upon excessive fatness, is probably of more importance than many think. A hen in thin condition will not produce a maximum number of eggs. It is especially important that the hens have a reserve store of fat at the beginning of the laying season if they are to produce a large number of eggs during the year.

Lot 3 consumed 17.4 percent more feed per hen than did Lots 1 and 2. A claim frequently made for variety rations is that they will increase the consumption of feed. This claim is probably based on fact. However, if the increase in egg production is not sufficient to pay for the additional amount of feed consumed, as well as for the higher cost of the ration per pound, it would be better to feed a simple ration even though the egg production per hen is somewhat less.

The average egg production per hen was 2.1 percent higher for Lot 2, and 8.4 percent higher for Lot 3 than for Lot 1. The cost of feed per dozen eggs produced was 27 percent higher for Lot 3 than for Lots 1 and 2 .

Figures given in the last column of Table II show that the difference between cost of feed and value of eggs per hen was 17

cents more for Lot 2, given a ration of corn, bran and meat scrap, and 11 cents more for Lot 1, given a ration of corn and meat scrap, than for Lot 3, given the variety ration.

While the two experiments discussed in the preceding pages cannot be considered as giving absolutely conclusive evidence regarding the advisability of using simple or variety rations, they do show that the rather common opinion that corn is too "heating" for very extensive use in rations for laying hens, especially during the summer, is not based on facts. In Ohio, corn under usual market conditions is one of the most economical feeds for laying hens, and can well be used to a very large extent in their ration. To be sure, corn must be supplemented with a nitrogenous feed, such as meat scrap or skimmilk, if good results are to be obtained from its use.

A more detailed report of these experiments, as well as a report of experiments in the comparison of range and confinement and a comparison of rations carrying various amounts of protein for laying hens is given in Bulletin 291, which may be secured upon request to the Experiment Station, Wooster, Ohio.

SORGHUM AND MILLET

F. A. WELTON

Compared with the staple forage crops of Ohio like corn, red clover and timothy, sorghum and millet, at best, are of secondary importance. The farms, if any, on which they are grown regularly are the exception rather than the rule. However, as a result of unforeseen circumstances, such as the failure of a regular crop in the rotation or of unseasonable weather conditions, it sometimes becomes advisable to seed one or both of them. The methods usually employed in handling these crops and the relative value of the various varieties of each as determined by their average yields on the Experiment Station farm are given herein.

SORGHUM

The name sorghum is applied to a group of plants grown for a variety of purposes—syrup, grain, broom-brush—all of which furnish forage as a by-product. In Ohio, however, sorghum is grown almost exclusively for forage. Formerly it was grown quite extensively for the production of syrup, but now that industry has been almost discontinued. It has never been grown extensively in this State for either grain or broom-brush.

Adaptation.—As compared with corn, sorghum is more resistant to drouth and excessive heat and does not require as great humidity of the atmosphere. On account of these properties it is equal to or even better than corn for semi-arid regions like western Kansas and Nebraska, where the average annual rainfall is less than 25 inches. In such sections yields as high as 20 bushels per acre have been reported when corn, from lack of moisture, was a failure.

In this State, however, where the annual rainfall, as an average of 27 years, is 37.83 inches, the possession of these characteristics is, in normal seasons at least, of no particular advantage, as may be noted from Table I, in which are reported comparative yields of corn and sorghum.

TABLE I.—Corn vs. sorghum

Variety	Green weight per acre (tons)				
	1912	1913	1914	1915	Average
Corn: Blue Ridge	20.71	12.55	12.14	12.54	14.48
Corn: Hickory King	18.43	12.34	10.18	11.61	13.14
Corn: Boone County White	16.98	10.88	10.47	11.48	12.45
Corn: Darke County Mammoth	15.04	7.26	8.57	11.10	10.49
Corn: Leaming, P. D.	11.48	8.43	5.86	8.05	8.45
Sorghum	13.91	11.95	8.82		11.56

Only the earlier varieties yielded less than the sorghum, and in actual dry matter undoubtedly the difference was much less than indicated in the table, because at the time of harvest there was a marked difference in the degree of maturity, the sorghum being much greener than the corn, that is, than the Leaming and Darke County Mammoth varieties.

With respect to soil, sorghum is not exacting, the requirements being similar to those of corn. Good drainage is essential and a silt loam with porous subsoil is preferable. On poor land it is often grown because under such conditions it yields more than many other forage crops, and the quality of the forage is inclined to be finer than when grown on more productive land. Sorghum has the reputation of being "hard on the land," but usually the effect is not marked after the first one or two crops following.

Culture.—While sorghum will make a good showing on thin land, yet with the liberal use of fertilizers the yields are increased in the same proportions as are those of other crops. Too much stress cannot be laid on the importance of preparing a good seed bed; one that is firm, fine and above all things clean—this for the

reason that sorghum seedlings grow slowly, especially if the weather is cool, and in competition with weeds for the possession of the land they are easily outclassed by the latter, especially if sown solid and not in rows so that they can be cultivated. However, they can be harrowed with little or no injury till they are 4 to 6 inches tall.

Sorghum

Sorghum is easily injured by frosts, and for that reason the seeding should be deferred till the customary time of frosts is past and the ground is thoroughly warm, usually from May 20 to June 10. Seedings may be made at any time later, providing moisture conditions are favorable; but few, if any, of the common varieties can be counted on to reach maturity when planted late.

Sorghum may be seeded in rows 36 to 42 inches apart, 8 to 15 pounds of seed being used per acre, or it may be sown solid, from 1

to 2 bushels being used per acre. In either method the use of the larger amount of seed tends toward the production of forage of a finer quality. It is usually sown in rows except when wanted for hay.

If seeded in rows the seed may be distributed with a corn planter, but in some cases special plates are required. By stopping a part of the runs, a grain drill may be used.

Harvesting.—Sorghum is utilized as soilage, silage, fodder, hay and occasionally, but with precaution, as pasture. Probably it is most useful in this State as soilage. It is consumed with rather less waste than corn and its resistance to dry weather makes it a useful crop to furnish succulent feed during the hot dry months of late summer and early fall. From the time it heads and for about two weeks thereafter it is at its best as regards both yield and quality. Therefore, if it is wanted for continuous soilage, seedings should be made at intervals of about two weeks.

The more common varieties have been grown on the Station farm and the comparative yields are given in Table II.

TABLE II.—Yield of green forage per acre (tons)

Year	Variety				
	Amber	Orange	Red Kafir	White Kafir	Yellow Milo
1912	6.2	10.7	5.9	6.9	4.9
1913	11.9	15.2	9.8	10.6	7.9
1914	12.5	16.1	12.8	13.4	10.4
1915	9.1	14.2	8.1	8.7	7.1
4-year average	10.0	14.0	9.1	9.9	7.6

Varieties.—Amber and Orange are the most useful for the production of forage. Ordinarily Amber is from one to two weeks earlier than Orange. The other three are commonly called grain sorghums, because it is for that purpose they are usually grown in the principal sorghum-growing districts.

Feterita is another one of the grain sorghums, but of more recent introduction, it having been brought to this country, according to Piper, in 1906. It has been grown for two years on the Station farm, but the average yield was less than that of any of the other grain sorghums for the same years.

In all of the varieties mentioned above the pith is juicy, the juice being most abundant and sweetest in the saccharine group of which Amber and Orange are members. Of the broom-corn type,

which is characterized by a dry pith, this Station has grown for the two years two varieties, Kowliang and Shallu, and, in the production of forage, both yielded less than any of the grain sorghums, including Feterita.

MILLET

Agriculturally millet is a broad term, it having been applied to many different groups of plants having wide variation botanically. However, all are alike with respect to the following: They are annuals, thrive in hot weather and are useful as forage. The most common groups are the foxtail, broom-corn and barnyard millets.

Culture.—Fair results may be obtained on quite a variety of soils; but, on account of the fact that millet makes its complete growth in a short period of time, the most satisfactory results are obtained only on the richer soils or from the liberal use of fertilizers on the poorer soils, the more readily soluble forms being used.

A well prepared seed bed is best, though millet will get along with less preparation in this respect than will sorghum.

Millet is very sensitive to frost, and hence should not be seeded till the arrival of continued warm weather, usually two or three weeks later than the regular time of planting corn. In normal seasons, seedings of the earlier sorts like the Hungarian may be made as late as the middle or latter part of July with fair prospects of a profitable crop.

From two to three pecks per acre is regarded as a good seeding, the larger amount being preferable for the foxtail type and the smaller for the barnyard. The seed may be distributed with an ordinary grain drill or it may be sown broadcast and harrowed in. In some sections millet is grown for seed and in this event it is usually grown in rows so that it may be cultivated. It can be thus distributed by stopping a part of the runs of a grain drill.

Harvesting.—Millet is utilized chiefly as hay, though it is sometimes grown for soilage, silage, pasture and seed.

Some of the principal varieties grown in Ohio have been tested on the Station farm and the comparative yields are given in Table III.

Different types of millet

TABLE III.—Yield of dry forage per acre (tons)

Year	Group						
	Foxtail			Broom-corn			Barnyard
	Hungarian	German	Red Siberian	White French	Broom corn	Early Fortune	Japan
1904	3.9	5.1	3.8	5.1	.....	.....	6.4
1905	3.4	6.1	3.0	4.4	.....	.....	5.9
1909	2.8	4.8	3.4	2.4	.....	.....	6.3
1912	2.2	3.5	2.1	2.3	2.3	2.0	4.5
1913	1.9	4.6	3.0	1.5	1.9	1.5	4.6
1914	1.6	3.5	1.9	.....	.....	.....	2.3
1915	2.6	3.5	2.6	.....	.....	.....	3.6
7-year average	2.6	4.4	2.8	.....	.....	.....	4.8

Groups.—For Ohio, the foxtail millets are most useful and of this group the Hungarian and German are the most common varieties. Hungarian millet, commonly called Hungarian grass, is earlier than German millet and, as may be noted from Table III, it yields less. On upland and in the northern part of the State where seasons are shortest the Hungarian is preferable to German. The latter is coarser, fully two weeks later, and, as indicated in Table III, it yields more. In southern Ohio, and especially on rich river bottom land, the German is preferable to Hungarian. The Red Siberian is one of the earlier varieties, ripening about the same time as the Hungarian.

The broom-corn millets are not commonly grown in Ohio, but in the semi-arid regions of the Northwest they are grown quite extensively, mainly for seed.

Barnyard millet has yielded more per acre than any of the other millets tested at this Station, but on account of the coarseness of the forage it is less satisfactory than are the foxtail millets. The most common variety of this group is sometimes called "Billion Dollar Grass."

POTATO INSURANCE

D. C. BABCOCK

If you intend to grow a crop for all that you can make from it in dollars and cents, why not use every precaution to make it a paying investment? Mr. Wm. Dennis, of Lincolnshire, England, who plants 1,500 acres to potatoes each year, says: "Potato growing, when given proper attention, returns more revenue for capital and labor invested than any other crop."

Every potato grower should select some variety which best answers his needs and then by proper cultivation, spraying and seed selection maintain his crop, both as to quality and quantity, up to the highest standard. Potato varieties do not "run out" if the grower is careful in selecting his seed, and does not plant culls which the buyers reject. The Peachblow variety has "run out" in most districts, as the popular expression goes, but this one variety has been grown continuously in Colorado for 40 years on one man's place, and this has been done successfully.

After you have gone to all the expense of preparing the field and planting it, why should you leave the outcome of the crop to chance? The formation of the tubers takes place following the time of blossoming, and it is at this later period that the plants need to be in the best condition. The following table, taken from the Vermont Experiment Station Bulletin 72, proves this statement.

TABLE I.—Yield of tubers at different dates: White Star variety, planted May 20

Date of digging	Total yield per acre	Yield marketable	Average size of tubers
	Bushels	Bushels	Ounces
August 2	58	30	1.6
August 12	115	75	2.0
August 22	230	163	3.7
September 1	304	234	4.4
September 12	356	303	5.2
September 22	379	353	5.7

Any disease which reduces the amount of foliage reduces the amount of food manufactured, and therefore cuts down the yield. Bordeaux is the spray mixture above all others which give good results in keeping foliage healthy, but it will be an expensive process unless the spraying is done thoroughly. One would better not spray than to go to the expense of spraying and then do a poor job. Proper spraying not only protects the plants against fungous diseases and insect enemies, but excites a vigorous growth.

It takes about 75 gallons to spray an acre of potatoes, and this would mean six pounds of copper sulphate to every acre if the 4-4-50 formula is used. Even at the price of copper sulphate now, it would not cost more than $5 an acre for the spray materials for four sprayings, and the price of copper sulphate is declining. Results heretofore obtained indicate that the yield would be increased from 50 bushels up, according to the amount of care exercised in applying the spray, and the number of applications, and to how long the plants are kept in a healthy condition. Spray thoroughly and as often as you can, and thus insure a potato crop.

The recommendations of the Department of Entomology for insect control are as follows: For the control of the Colorado potato beetle and other leaf-eating insects which attack the potato, arsenical poisons should be combined with the Bordeaux sprays. Arsenite of soda and arsenate of lead make a good combination; the first ingredient to give immediate results because of its quick action, and the second to give long-term insurance because of its adhering qualities. To prepare arsenite of soda, dissolve two pounds of commercial white arsenic and four pounds of carbonate of soda (washing soda) in two gallons of boiling water, and use from one quart to three pints to a barrel of Bordeaux mixture (50 gallons). Now add to the barrel of mixture five pounds of arsenate of lead and apply.

THE NECK ROT OF WHITE ONIONS

J. G. HUMBERT

Practically all the white-onion growing in Ohio is centered in Hardin County, and from this district comes a considerable percentage of the white onions raised in the country. Onion growing is a highly specialized branch of farming, and the onion, not unlike many other crops, is subject to ravages of insect pests and fungous diseases.

Inasmuch as heavy losses from diseases in stored onions have occurred for many years in Hardin County, the growers often suffering losses of 15 to 75 percent of the crop, it has become a problem of no small importance to diminish losses and prevent entirely, if possible, this waste. This storage disease is neck rot (see illustration No. 1), often miscalled "smut." It attacks the onions after they are harvested. The true smut of onions is a soil-infecting disease which attacks the seedling onions at an early stage. The neck rot

is known to be widespread over the Scioto marsh and adjacent areas where white onions are grown and stored on a commercial scale. This disease is recognized and spread by minute bodies known as spores, which correspond to seeds of higher plants. In April and May these spores have been found viable and able to produce the disease, on crates and in storage houses which had contained diseased onions the previous winter. They have also been found viable on refuse piles one, and even two years old. Considerable data are at hand, both from experimental research and from field observation, covering the history of this onion pest, and the evidence all points to two available means of control: First, a general clean-up, embodying strict sanitary measures; second, fumigation of newly topped, crated onions. It is the purpose of this preliminary article to call attention to the need for sanitation measures, and to include certain data on the treatment of the freshly harvested onions.

White onion destroyed by neck-rot fungus. This parasite has entered the onion through the green neck which was cut off at the time of harvesting the crop. (From Ohio Agr. Exp. Sta. Bul. 214)

SANITATION METHODS

Since it is known that the disease lives over winter outdoors on refuse piles of diseased onions, it is plain that the first problem is to get rid of such sources of infection. It is granted that to destroy every diseased onion is almost impossible, but certain sanitary measures can and should be put into practice. Undoubtedly the fact that none or very few onions were stored in the vicinity the past season will materially reduce the task in the field, since there have been no fresh dumps made. The fence corner dump heap common on many farms should be gotten rid of early this season, either by deep burial or by burning. In order to burn onion refuse it will be necessary to spray the dumps with crude oil or similar combustible before setting on fire. The same remedy should be applied to diseased onions scattered broadcast over fields. If these are not plowed under deeply or burned in the spring they may

become a source of living spores that will spread the disease when the next crop is harvested. It is granted that onion refuse is difficult to burn, and that some benefits are derived from the organic fertilizer. Nevertheless it is strict economy to follow such practices as will reduce losses. sometimes amounting to one-half the matured crop.

The storage houses and crates should also be thoroughly cleaned up for the same reason; namely, they are possible harbors for the spores causing the neck-rot disease. Before any crates are used to store freshly topped onions they should be thoroughly sprayed, or better still, dipped in a solution which would kill all germs. Likewise the house, after a thorough cleaning out, should be sprayed with a like solution. In about 24 hours the storage house should be sprayed again. There are several chemical solutions that will be effective. The two most promising are formaldehyde solution, using 1 pint, 40 percent U. S. P., to 30 gallons of water; and the copper sulphate solution (blue vitriol), using 1 pound to 25 gallons of water. As is the case with field dumps, a thorough clean-up will be necessary, considering the ease with which the disease is spread.

EXPERIMENTS IN FUMIGATION

Following recommendations given from this Station to fumigate freshly harvested onions in the field several years ago, several attempts were made by storage men in the white-onion district to control neck rot by fumigating storage houses. Results obtained varied considerably, but there was some evidence that when fumigation was carefully carried out there was a reduction in the losses sustained. During the summer of 1915 careful experiments were planned, and these were to have been tried in cooperation with W. C. McGuffey, of McGuffey, Ohio, at and following the onion harvest. Floods destroyed practically the entire crop, and these field experiments were postponed. However, with white onions grown at the Station gardens a few experiments were carried out. Conditions were attempted resembling those of the open field and storage house for the inoculation and fumigation experiments.

At the time of topping and after being crated, the onions in part were exposed to a spray of live spores, obtained both from pure cultures of the fungus, and from onion refuse gathered from the field and storage houses. A small portion (1 basket) was not exposed to the disease, as far as could be determined. The freshly topped onions were divided into four lots and placed in wire baskets

of approximately two and one-half quarts capacity. The average number of onions per basket was 43. The lots consisted of and were treated as follows:

Lot 1. One basket, not inoculated, not fumigated.
Lot 2. Five baskets, inoculated, not fumigated.
Lot 3. Six baskets, inoculated, fumigated 24 hours.
Lot 4. Six baskets, inoculated, fumigated 72 hours.

The chamber used in fumigating was a cage nearly air tight of about 100 cubic feet capacity. Formaldehyde gas was generated in this chamber in which the onions, Lots 3 and 4, were placed the day following topping and inoculating. Formaldehyde, 40 percent U. S. P., and potassium permanganate were used at the rate of 3 pints of formaldehyde to 23 ounces of potassium permanganate per 1,000 cubic feet of air space. The greater part of the gas was generated when the onions were placed in the chamber. At the end of 24 hours Lot 3 was removed, and a much smaller amount of gas was generated, and again at the end of the 64th hour. After fumigation the onions were raked up and covered so as to approximate field curing conditions.

Observations were made and notes taken as to the behavior of the different lots. One week after fumigation it was very evident that considerable infection had taken place in Lot 2; an occasional diseased onion was found in Lot 3; and none were apparent in Lots 1 and 4. A careful count was made eight weeks after fumigation. At this time Lot 2, not fumigated, had 78 percent of the onions infected with neck rot; Lot 3, fumigated 24 hours, had 23 percent, while Lot 4, fumigated 72 hours, had only 2 percent; Lot 1 was entirely free from disease. At the time the count was made many onions were affected with the bacterial soft rot. This trouble increased rapidly so that no accurate data could be obtained later in the winter as to the keeping qualities of the fumigated and unfumigated lots. Slugs invaded the baskets and did considerable damage, undoubtedly spreading the neck-rot disease, as well as the soft rot.

It is evident from these figures that the fumigation with formaldehyde gas has materially reduced the amount of disease. It is also certain from this that the disease can get a foothold in the onion at the time of topping. Other experiments were made about the same time which showed some evidence that infection took place very rarely after the onions were allowed to dry before being topped.

Attempts during 1915 to infect white onions with the neck-rot disease in the gardens were unsuccessful. Spores from pure cultures were sprayed on growing onions, tops and bulbs, with an atomizer. In a part of the plots wounds were made on leaves and bulbs. The method was as follows:

50 white onions punctured in bulb and inoculated.
150 white onions *not* punctured in bulb and inoculated.
50 white onions punctured in leaves and inoculated.
150 white onions *not* punctured in leaves and inoculated.

Careful observations on these inoculated plots were made from time to time for two months, and up until and including the time when the final examination was made at the time of pulling, not one infection was found.

CONCLUSIONS

While the neck-rot disease has been reported from the Hardin County onion district as a destructive disease since 1905, the progress in control measures has been slow. The foregoing statement records what has been accomplished from the practical side. One serious barrier to progress has been an apparent reluctance on the part of onion growers to recognize the disease as a specific trouble, and to use a distinct name for it, viz, Neck Rot (*Sclerotium cepivorum* Berk.). The smut disease, with which it has been confused, attacks almost exclusively the young seedling onions, and is in no wise associated with neck rot. The smudge or anthracnose fungus disfigures the exterior of the white onion bulbs without causing much rotting. No more serious disease of any vegetable grown in the State is at present known than this neck rot of the white onion. The grower faces the alternatives of making a greater effort to control it or being forced to abandon this crop entirely and let it be grown elsewhere. The urgency of sanitation measures is emphasized since they are vital to the industry. Dump heaps of onions rotted by the disease cannot be permitted if the crop is to succeed. In like manner the crates and storage houses require to be disinfected if the clean new crop is to be kept free from infection and subsequent losses from this disease.

THE CLOVER LEAF TYER (*Ancylis angulifasciana* Zeller)[1]

H. A. GOSSARD

In early April, 1905, my attention was attracted to the ragged, eaten condition of the clover leaves on the Station farm. A great army of small, leaf-tying caterpillars was found to be responsible for the damage. The injury rivaled that being inflicted at the same time and in the same field by the clover leaf weevil, *Phytonomus punctatus*, which so commonly eats the leaves full of circular holes in early spring. A little later a swarm of small Tortricid moths appeared in the field, the chrysalid shells being numerously exposed in the trash and among the leaves where the caterpillars had fed. I have not since seen this insect do so much damage as in 1905, and nowhere else than in this Station field have I ever seen any severe damage; but every year it is a somewhat inconspicuous inhabitant of Ohio clover fields, doing more damage than one is likely to suspect. Very little has been published relating to the insect, the entire matter being comprised in the original description by Zeller, published in 1875, and in a brief note on the egg-laying habits of the moth by Dr. C. H. Fernald, published in two entomological magazines.[2]

FOOD PLANTS AND CHARACTER OF DAMAGE

The known food plants are common red, alsike and white clovers. The mammoth red clover is very probably eaten. From laboratory tests, I conclude that alfalfa is eaten only under compulsion and that the larvae cannot live long upon it. I have not tried to feed the larvae on the sweet clovers, but doubt if these are any better suited to their sustenance than alfalfa.

Clover foliage eaten by the caterpillars exhibits a ragged appearance, the epidermis from one of the surfaces being either partly or wholly eaten away, while the epidermal cover remaining appears thin, papery and white, except for minute splotches and streaks of green here and there, which through chance were left uneaten. Either the upper or lower surface will be eaten, whichever happens to be turned inward in the leaf-cell or habitation which each caterpillar constructs for itself.

DESCRIPTION

Moth.—The moth is the most conspicuous stage of the insect and the one most likely to attract observation. The wings measure

[1]Extract from Ohio Agr. Exp. Sta. Bul. 297.
[2]Psyche, III, 88. Trans. Am. Ent. Soc., X, 50.

about one-half inch across from tip to tip when fully expanded, but the insect is most readily recognized when at rest on green foliage, such as a clover leaf. The length from the head to the tip of the wings, when so resting, slightly exceeds one-fourth inch. A pear-shaped or egg-shaped patch of silky dark brown on the back, extending from the head back to the middle of the wings and surrounded by a ring of satiny creamy-white, furnishes a striking recognition mark. Some brownish or buff markings are seen farther back on the wings, and on the lower (front) margin of the fore-wings near the tips is a series of five to seven short, alternating buff and glistening white lines.

Caterpillar.—The caterpillar, or larva, when newly hatched, is so small (about one-twentieth inch long) that a magnifying glass is used to detect it. When full grown, the body is greenish to yellowish-green, about one-third of an inch in length; the head is black with some yellow.

Pupa.—The pupa is barely less than one-fourth of an inch long; abdomen is light yellowish-brown; other parts are greenish straw-yellow, all becoming darker as maturity approaches. It is fastened to the cocoon wall at the posterior end by a strong wisp of silk caught over a circle of eight to ten hairlike, microscopic hooks. A light lining of whitish silk within the larval feeding cell, or within a leaf similarly folded, serves for a cocoon.

Egg.—The egg is a dull grayish-white dot, or greenish as the leaf color passes through it, adhering to either surface of the clover leaf.

LIFE HISTORY AND HABITS

First brood.—The hibernating caterpillars, from one-half to two-thirds grown, commence feeding in late March or early April, according to the season, and reach maturity about the middle of April when they pupate in their feeding cells. The pupal stage lasts from one to two weeks, and then the moths appear from late April till early June, most of them coming during the last half of May in average seasons. The individual moth lives from nine to twelve days. The eggs are laid on either surface of the leaflets and hatch in from two to three weeks. The young caterpillars are first seen about the first week in May, and the latest to mature are found about the middle of June. They are most conspicuous about the last week in May. The pupal period lasts from seven to fourteen days.

Clover leaf tyer (*Ancylis angulifasciana*) moths (much enlarged) resting on clover leaf

Second brood.—The moths of the second brood are flying from the last days of June until about July 20, being most numerous from July 10 to 15. The caterpillars of this brood range from about July 15 to the last week of August. The pupae are found from about the middle of August till the middle of September.

Third brood.—Moths of the third brood may be seen from September 1 to 20. The caterpillars are in evidence from early October until the following April, pupating from the middle of the latter month until in early May.

Habits.—When disturbed, the moths by quick movements may slide into the stubble or trash of the field, where their coloration harmonizes so perfectly with their surroundings that they are almost undiscoverable; or, they make a brisk indirect dash of from six to twenty feet and then alight. The young caterpillars immediately after hatching commence blundering around among the hairs which clothe the leaflets and, when they lose their hold, swing off into the air to descend by means of a silken thread to a leaflet below. Here they choose some natural or accidental depression or crease in the leaf surface, such as overlies the midrib, and tie the opposing surfaces together by a fine whitish expansion of silk, which with the leaf-walls forms a hollow tube within which the caterpillars hide and feed; or very often two leaflets, one of which overlies the other, will be tied together with silk, and the caterpillars will feed between them. Such leaflets may be on the same or different stems, or petioles. As the caterpillars grow older they show a tendency to construct cells of considerable size, usually three-sided, each side consisting of a leaflet. When the green leaf-pulp of all the cell-walls has been consumed, the caterpillar abandons the impoverished home and constructs a new and larger one in which it repeats its earlier history.

MEANS OF CONTROL

From the detailed life history given, it is apparent that the first clover harvest coming in late June and early July, or earlier, will carry to the mow many of the larvae and pupae of the first brood, and that the second cutting will take off most of the second brood of pupae. Fall pasturage will destroy many of the third brood. The present well-established customs for harvesting and pasturing clover furnish a logical and effective program for control.

Upper illustration.—Red clover leaflets eaten by caterpillars of clover leaf tyer. The leaflet at the left folded back shows the chrysalis, or pupa, lying in a bed of white silk. Lower leaflets inclose larvae.

Lower illustration.—Caterpillars of clover leaf tyer.

THE MINERAL REQUIREMENTS OF THE MILCH COW[1]

E. B. FORBES

The dairy cow greatly excels any of the other farm quadrupeds in the rapidity and efficiency with which she produces proteid and mineral nutriment, and since the cow is only a transformer, but in no sense a creator of these nutrients her maximum productive capacities depend upon as unusual requirements for the kinds of nutriment especially involved.

The unusual requirement of the cow for protein in the ration is universally recognized, and receives that attention which its importance demands. The mineral requirements of the milch cow, however, have received but scant recognition. There is in the literature almost no evidence on the subject, and we ordinarily assume that cows get enough mineral matter in the ration at all times. The results of recent work at the Experiment Station show that in this assumption we have been in error, and that we have important facts yet to learn regarding the mineral requirements of profitable milch cows. In this experiment we sought to study the mineral income and outgo of the milch cow on common practical rations, especially as influenced by the protein concentrates and by the type of roughage fed.

The rations fed were the following:

Corn, cottonseed meal, timothy hay, corn silage
Corn, cottonseed meal, clover hay
Corn, cottonseed meal, clover hay, corn silage
Corn, distiller's grains, clover hay, corn silage
Corn, linseed oilmeal, clover hay, corn silage
Corn, gluten feed, clover hay, corn silage

These rations, therefore, afford a basis for the comparison of clover and timothy hay, and of the common commercial nitrogenous concentrates.

This investigation was conducted by the usual method of the metabolism experiment, involving the collection, sampling and analysis of food, urine, feces and milk. Six cows were used in this investigation. They were all grade Holstein-Friesians except one which was purebred. The cows were from 3 to 5 years of age, and all were fresh from 4 to 6 weeks before the experiment began. The cows were used in two groups of three each, three cows to a ration.

The average daily yield of milk during the experiment was 36.1 pounds. It was our wish to keep the cows as nearly as possible

[1]Extract from Ohio Agr. Exp. Sta. Bul. 295.

at a constant weight. Five of the six gained in weight during the experiment as a whole. The average change in weight was a gain of 3 ounces per head per day.

Salt was fed in the amount of 1 ounce per head and day. This was usually enough to keep up the body-supply of the elements composing salt, but a somewhat greater quantity would not be excessive.

With each cow, on each ration, there was given off from the body, in milk and excreta, more calcium and magnesium than was present in the food. There was also loss of phosphorus in 15 cases out of 18. The quantities of these elements lost show that they were withdrawn from the skeletons of the cows.

These losses were not due to general undernourishment, because the cows maintained their live weights, and each cow, on each ration, gained in nitrogen and sulphur. These gains show that protein was being stored.

Certain of the rations fed contained three times as much calcium as did other rations, but the losses of calcium were not correspondingly less. The losses of magnesium and phosphorus seem to have been incidental to the losses of calcium, since calcium was much more deficient in the rations, and since none of the three can be stored in quantity except as associated in the bones.

The slight response of the cows to increase in the calcium of the rations indicates a limited capacity to digest calcium after a certain level of food consumption and milk production is reached. It seems that in the selective improvement of the milch cow, the capacity to produce milk has outrun the capacity to digest minerals, with the result that the cow must draw upon her own bones to supply the deficiency.

From this study it appears that a failure to maintain mineral equilibrium must be so common among cows of the more profitable sort that it may be considered a normal condition during the time of larger production, at least if this occurs during the winter, that is, while the cows are off pasture.

A common failure of cows to maintain exceptionally high production during consecutive periods of lactation may be due to mineral depletion, as may also be a frequent failure of cows to breed after having been subjected to a period of forced production, as in the establishment of records.

Since extensive milk production is sustained, in part, by drafts upon the mineral reserves of the body; since this process cannot continue indefinitely; and since there is in cows a gradual shrinkage

and final cessation of milk production coincident with this depletion of nutrient reserves, it is believable that this mineral exhaustion may be among those factors which cause the gradual shrinkage of milk, and that by preventing, as largely as possible, these losses from the body we may be able to lessen the shrinkage and to extend the duration of the production of milk.

The results of this study indicate that especial attention should be given to the calcium, magnesium and phosphorus contents of the rations of heavy-producing cows, in order that the loss of these elements from the skeleton may be kept as low as possible; and a liberal supply of foods rich in these elements should be allowed after a cow has ceased to produce heavily, during the latter part of the period of lactation, in order to refund previous overdrafts before the birth of the next calf.

RAW ROCK PHOSPHATE VS. ACID PHOSPHATE

C. E. THORNE

The increasing price of acid phosphate, due to the demand for sulphuric acid caused by the European war, is directing attention to the possibility of substituting for acid phosphate the finely ground raw phosphate rock from which acid phosphate is made by treatment with sulphuric acid.

In 1884 the Pennsylvania State College began an experiment in which raw phosphate rock, obtained from South Carolina, was compared, not with the same rock treated with sulphuric acid, but with "dissolved boneblack," which was then the more common carrier of available phosphorus. This experiment was continued for 12 years, the phosphate being applied to corn and wheat in a 4-year rotation of corn, oats, wheat and clover, and in connection with materials carrying uniform dressings of nitrogen and potassium to all the land. The outcome was an average annual increase per acre over the cost of the fertilizer to the value of $1.93 for the raw phosphate rock and $1.10 for the dissolved boneblack.[1]

For 9 years, from 1886 to 1894, the Maine Experiment Station conducted an experiment in which acidulated phosphates, consisting at first of dissolved boneblack, but later of acid phosphate, were compared with ground South Carolina rock, the fertilizers being applied in large quantities but at irregular intervals, on oats, hay, peas and corn, grown in succession, with the result that the average annual increase from the acidulated phosphates was 570 pounds per

acre and from the raw phosphate 271 pounds. In this case the cost of the fertilizer would have been approximately $2.00 annually in the case of the acidulated phosphates and 80 cents annually in the case of the raw rock, at prices at which the two materials might have been purchased and applied to the land at average Ohio points during recent years. Rating the increase at $12 per ton, the net gain per acre would have been $1.42 for the acid phosphate and 82 cents for the raw rock.[2]

In 1890 the Massachusetts Experiment Station began a field investigation on this subject, which was continued for 12 years. The crops employed were grains and truck crops, and raw phosphate rock was found to be slightly more effective in proportion to cost, than dissolved boneblack.[3]

Another experiment was begun by this Station in 1897, which was continued for 18 years, the crops being chiefly truck crops. In summing up the results of this test the average annual gain per acre over the cost of the phosphates is computed by the experimenters as $6.21 for the raw phosphate and $34.57 for the acidulated phosphate.[4]

In 1894 the Rhode Island Experiment Station began a comparison between different carriers of phosphorus which was continued for 20 years. The application of phosphates was discontinued in 1902, at which time the total amount of phosphorus applied had amounted to the equivalent of 738 pounds of phosphoric acid, in each carrier, but the crop yields were separately ascertained until 1913, when the total values of increase per acre were found to be as below:

	On limed land	On unlimed land
From raw phosphate	$269.10	$358.80
From acid phosphate	486.90	440.50

Computing 28 percent raw phosphate at $10 per ton, spread on the land, and 14 percent acid phosphate at $16, the cost of the raw phosphate for this test would have been $14.04 per acre, and that of the acid phosphate $38.57. Deducting these costs the net outcome per acre would be as below:

	On limed land	On unlimed land
From raw phosphate	$255.06	$344.76
From acid phosphate	448.33	401.93[5]

In 1895 the Maryland Experiment Station began a comparison of carriers of phosphorus which was continued for 12 years, during which period 6 crops of corn were grown, 2 of wheat and 2 of mixed hay. None of the phosphates produced any appreciable effect on

the corn crops, although the wheat and hay showed considerable increase; the acidulated phosphates producing the larger effect on the wheat, while the untreated phosphate seems to have been quite as effective on the hay crops.

The phosphates were applied in quantities sufficient to give 150 pounds of phosphoric acid annually, which would furnish all the phosphorus that the crops could utilize in the raw phosphate—a small percentage of which has been shown by all experiments to be available—hence there was no possibility of comparing the relative effectiveness of the treated phosphate.[6]

From 1904 to 1915, inclusive, the Illinois Experiment Station has conducted a triplicate comparison of phosphates in southern Illinois, in which acid phosphate has been used at a rate equivalent to 333 pounds annually and raw phosphate rock in double that quantity. In the total outcome for the 9 years the increase has been practically the same for both carriers of phosphorus, but in neither case has the cost of treatment been recovered in increase of crop. In this case again phosphorus has been applied in acid phosphate in quantities beyond the ability of the crop to utilize it, and hence the raw phosphate rock has had an undue advantage.[7]

The Indiana Experiment Station has compared acid phosphate and raw phosphate rock in its Scott county experiment field for the 9 years, 1905-13, and finds that the net profit from the acid phosphate for this period has been $71.84 and from the raw phosphate, $54,58.[8]

In 1897 the Ohio Experiment Station began an experiment in the reinforcement of manure with phosphates, the plan of which is given in Bulletin 183 and the results up to 1913 are summarized in Circular 144.

Reckoning corn at 50 cents per bushel, wheat at 80 cents, stover and straw at $2.50 per ton and hay at $10, the financial outcome of the comparison of phosphates in this test for the 19 years, 1897-1915, would be as follows:

Comparison of phosphates. Annual value per acre for the 19 years, 1897-1915

Plot No.	Treatment	Annual value of produce	Increase for treatment	Increase for phosphate
1	None	$16.97		
2 and 3	Manure and raw phosphate	27.94	$12.56	$3.15
4	None	13.79		
5 and 6	Manure and acid phosphate	28.32	14.76	5.35
7	None	13.33		
14	None	13.63		
15 and 16	Manure untreated	23.45	9.41	
17	None	15.46		

The manured plots are compared with the untreated plots between which they lie, as this is the only way in which errors due to natural variations of soil may be eliminated. It will be observed that the yields on Plots 1 and 17 were larger than those on the intermediate unmanured plots, and a careful analysis of all the crop yields shows that these results were due to greater natural productiveness in the neighborhood of these plots.

Previous to the European war raw phosphate rock was being purchased in bulk carloads at prices equivalent to about $7.50 per ton, delivered at average Ohio points. During the same period 14 percent acid phosphate could have been purchased in the same condition and for the same delivery at about $11.50 per ton. Sacking would have added approximately $1.00 per ton in either case. Prices for acid phosphate have been considerably increased by the war, but it is probable that they will return to the former level when the war is over. Estimating the cost of hauling either phosphate from railway to farm and spreading it on the land at $2.50 per ton, the cost of the 320 pounds per acre used in this experiment (40 pounds per ton of manure, 8 tons per acre every third season) would have amounted to $1.60 for each rotation for the raw phosphate and $2.24 for the acid phosphate, or the equivalent of 53 cents and 75 cents annually. Deducting these costs, the annual net increase for the raw phosphate has been $2.62 per acre, and for the acid phosphate, $4.60. It has therefore been very profitable to use the raw phosphate, but so much more so to use the acid phosphate that it would not have paid to use the raw phosphate had it cost nothing.

In another experiment, begun in 1905, the Ohio Station is using raw rock phosphate and acid phosphate side by side on land that had been well manured before the experiment began but has received no manure since. This land is cropped in a 3-year rotation of corn, oats and clover, and the fertilizing materials are all applied to the corn crop. Three tracts of land are employed, and each crop is grown every season. The average unfertilized yields in this test have been 47 bushels of corn, 43 bushels of oats and 3,580 pounds of hay, showing that the soil is fairly well stocked with organic matter. The two phosphates have been applied at the same rate per acre as in the manure test, previously described. The average outcome for the 11 years, 1905-1915, is shown in the next table.

Here again, if we had nothing better, it would be very profitable to use the raw phosphate, the net gain having averaged nearly 170 percent of the cost of the fertilizer; but here again the acid phosphate has been decidedly the more profitable of the two materials,

the net gain from acid phosphate having averaged 240 percent. Even were the cost of the acid phosphate doubled the net gain would still be greater than that from raw phosphate.

Comparison of raw phosphate and acid phosphate, used in the absence of manure

Treatment	Annual cost of treatment	Annual value of increase	Annual net gain
Acid phosphate alone	$0.75	$2.44	$1.69
Raw phosphate alone	0.53	1.37	0.84
Acid phosphate and muriate potash	1.08	4.08	3.00
Raw phosphate and muriate potash	0.86	2.14	1.28
Acid phosphate, muriate potash, lime	2.08	6.70	4.62
Raw phosphate, muriate potash, lime	1.86	5.16	3.30

In conclusion, it is evident from these experiments that raw phosphate rock is a useful carrier of phosphorus, and may be used with profit on soils requiring phosphorus; but it is apparent that when raw phosphate and acid phosphate have been used side by side under such conditions as to fully utilize the crop feeding power of the two materials the acid phosphate has generally furnished available phosphorus at a lower cost than the raw phosphate.

It is true that the raw phosphate adds more phosphorus to the stock of unavailable phosphorus in the soil than does the acid phosphate, but if after a dozen to 20 years this addition does not begin to manifest itself in increased production the farmer may be pardoned for hesitating about making an investment for posterity which experience has not yet demonstrated that they will be able to realize upon.

Moreover, he who uses acid phosphate is making some investment of this sort; for in the 20-year experiments of the Ohio Station, in which a larger proportionate increase has been recovered from chemical fertilizers than has been reported in any other similar test, the largest recovery of phosphorus has been three-fourths of that applied in acid phosphate.

[1]Penna. State College, Annual Report 1895, pp. 157-210.
[2]Maine State College, Annual Report 1894, pp. 23-25.
[3]Mass. State Agr. Exp. Sta. 12th Annual Report 1894, pp. 257-261; Mass. Hatch Exp. Sta. 14th Annual Report 1912, pp. 24-28.
[4]Mass. Agr. Exp. Sta. Bul. 162, May, 1915.
[5]Rhode Island State College Agr. Exp. Sta. Bul. 163.
[6]Maryland Exp. Sta. Bul. 114.
[7]C. G. Hopkins in Prairie Farmer, Feb. 26, 1916.
[8]Purdue Univ. Agr. Exp. Sta. 27th Annual Report 1914.

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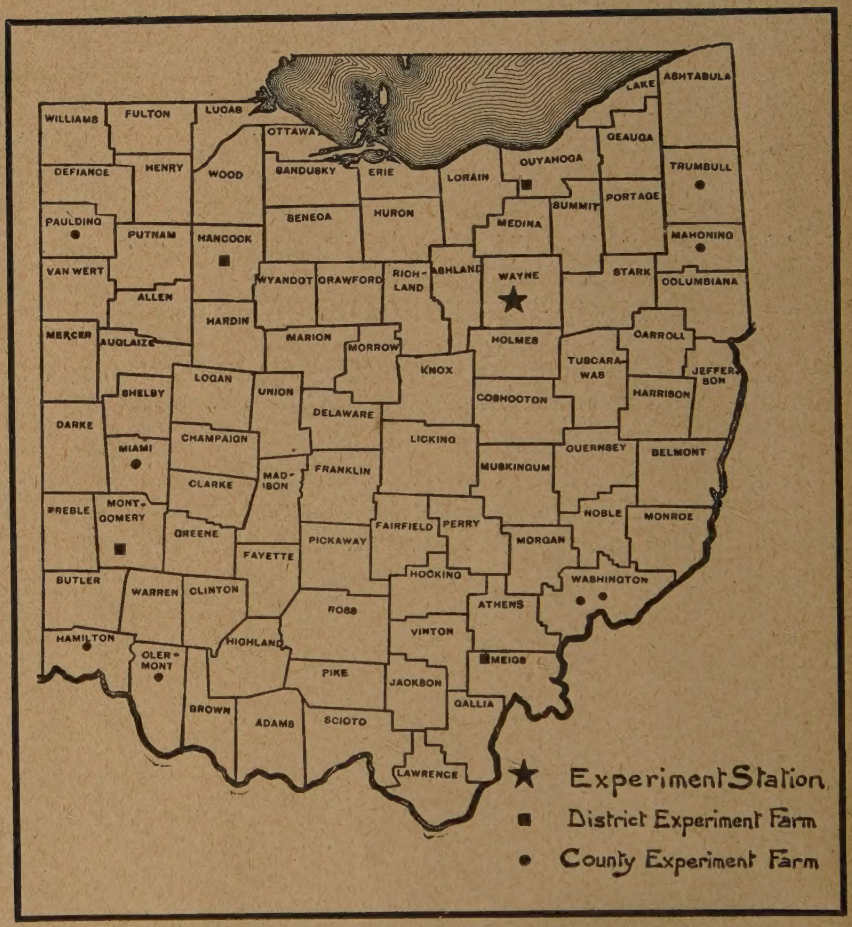
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